LXVIII. *A Method of working the Object Glaſſes of Refracting Teleſcopes truly ſpherical. By the late Mr.* James Short, *F.R.S.*[*]

Read Jan. 25, 1770.

PREPARE two plates or tools of braſs, the one convex, and the other concave, being both portions of a ſphere of the ſame radius as the focal length of the object glaſs you want to have, or rather of a radius ſomewhat longer than the focal length you want, for a dioptrical reaſon; let theſe plates or tools be between two and three times the breadth of the object glaſs deſired; or, in long focal lengths, twice the breadth will be ſufficient: let theſe tools be of a ſufficient thickneſs in proportion to their breadth or diameter, and let them be ground with fine emery exactly true to one another, working them alternately, the one above the other, to preſerve the ſame focal length; or, if it is deſired longer, you muſt work the convex above the concave; or, if deſired ſhorter, you muſt grind the concave above the convex.

After this, you prepare another braſs-plate or tool, of the ſame breadth and thickneſs as the two former,

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[*] This paper, which was delivered, ſealed up, by Mr. Short, at the Society, on the 30th of April, 1752, was, after his death, opened by the Council, and ordered to be printed.

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and of the ſame radius of concavity; its being truly turned on a lathe will be ſufficient for this purpoſe; which tool is to ſerve afterwards for the poliſhing of the two ſurfaces of your object glaſs, and therefore called the poliſhing tool.

Prepare a piece of ſtraw-coloured glaſs, of the plate glaſs kind, of the proper diameter for the object glaſs you deſire, which ought always to be broader than the proper aperture for that length; let this piece of glaſs be ground flat, in another tool, on both ſides, and as nearly parallel as may be, and ſomewhat poliſhed, in order to diſcover whether there are any veins or flaws in the glaſs. When you are ſatisfied of the goodneſs of the glaſs, you are then to prepare a handle to faſten your glaſs to. Great care muſt be taken in this, for fear of bending your glaſs by the handle; my method is this; I take a flat piece of braſs, or rather of the concavity of the ſphere, to which the glaſs is to be ground; this piece of braſs ſhould not be thicker than $\frac{2}{3}$ of the thickneſs of the glaſs, of a circular form, leſs in breadth ſomewhat than the glaſs itſelf, and having ſides of the ſame form, at right angles to the flat piece of braſs, and theſe ſides ought to be of ſuch a ſhape as that the fingers may eaſily apply to it in working, and theſe ſides ſhould be as low as may conveniently be, and no thicker than about $\frac{2}{3}$ of the glaſs. This handle is to be faſtened to the glaſs, by warming the glaſs and handle gently before a fire, and laying ſome pitch upon the glaſs thus warmed, till it becomes ſoft like melted wax; and then laying your braſs handle, a little heated, on the pitch, you preſs it a little, till you are ſure there is nothing between the glaſs and handle but pitch; you then lay down the glaſs and handle upon ſomething flat, taking care that the handle is in the middle of the glaſs, till it is entirely cold. It is very material to know, that the pitch, to be uſed for faſtening the handle to the glaſs, muſt be ſoft pitch, that has never been uſed, nor melted; for any other pitch will infallibly bend the glaſs.

You then grind your glaſs in the concave tool with emery, and give it the proper figure and ſmoothing for the laſt poliſh, in the common manner.

In order to give your glaſs the laſt poliſh, which is the moſt difficult part of the whole work, you are to prepare ſome pitch for covering the before mentioned poliſhing concave tool, which is done in this manner: Take ſome pitch, and melt it in an iron ladle, and let it boil for a quarter of an hour or thereabouts; by this boiling, the pitch, when cold, will become hard and brittle; or you may ſhorten this operation, by melting equal quantities of pitch and roſin, and then there is no occaſion to let it boil ſo long. Your pitch being thus prepared, you again melt it, and take it off the fire, and let it ſtand till the pitch becomes pretty cold, or of a thickiſh conſiſtence; and having warmed the poliſhing tool a little, to make the pitch ſtick to it, you pour out of the ladle upon the poliſhing tool as much of the pitch as you judge will cover the whole tool, when ſpread out, to about the thickneſs of $\frac{1}{8}$ of an inch; you then invert this tool with the pitch upon it, and preſs it upon the convex tool, which muſt be quite dry, clean, and cold, in order to give it the figure of the convex tool; in caſe it has not ſpread out ſo as to cover the whole ſurface of of the poliſhing tool, you warm the pitch by holding it before the fire, and preſſing it upon the convex tool, as before, till it has entirely covered the ſurface of the poliſhing tool; you then plunge it into cold water, till the braſs is quite cold.

N. B. In order to know if your pitch is hard enough, you preſs the edge of the nail of your thumb upon it, and if it receives an impreſſion, the pitch is not hard enough.

You then proceed to prepare this poliſhing tool, for the laſt poliſh of your glaſs, by grinding this poliſhing tool upon the convex tool with pretty coarſe emery, and a ſmall quantity of water, in the common way that tools are ground one upon another; but this muſt be done only for a ſmall ſpace of time, and the poliſhing tool muſt have no other preſſure than its own weight, for fear of ſome of the emery ſticking in the pitch, and you muſt never allow the emery to grow dry; when you have ground the pitch ſo as to be all over of the ſame colour, you then waſh the pitch from all the emery with a bruſh and clean water; after this you take a bottle of water, and holding the pitch tool in a ſloping poſition, you pour water out of the bottle ſo as to fall upon every part of its ſurface.

You then place the poliſhing tool in a horizontal poſition, and you put upon it ſome putty, waſhed from all its gritty particles, but it need not be the fineſt waſhing, and you put a good deal of water upon your poliſhing tool, mixing the putty and it together, and you poliſh your glaſs upon this pitch poliſher in the common manner of poliſhing glaſſes.

After you have poliſhed your glaſs about ten minutes, you again grind your poliſher upon the convex tool with emery, as before, for fear the pitch has, by working, loſt any of its proper figure; and the oftener you do this, the truer will be the figure of your glaſs; and in this manner you proceed till the glaſs is quite poliſhed.

You then take your glaſs off its handle, by holding it before the fire, till it is ſo warm that you can ſlide the handle off the glaſs; and whilſt the glaſs is warm, you take off as much of the pitch as you can with the ſharp edge of a knife; you then lay the glaſs down to cool, and, when quite cold, you drop ſome ſpirits of wine upon it; and this, with a cloth, will wipe off the reſt of the pitch.

You then examine the center of the ſurfaces of your glaſs; and if it lies to one ſide of the center of your glaſs, mark that place with a ſpot of ink, and then put on your handle as before, upon the ſide that is now poliſhed, with its center over the ſpot of ink, and grind your glaſs as before, till the circular remaining part of the glaſs to be ground is as much diſtant from the center of the glaſs on the other ſide from the ſpot as the ſpot was from the center of your glaſs; you then by heat return your handle to the center of the glaſs, and proceed to grind and poliſh this ſide of the glaſs as before.

N. B. The concave and convex tools ſhould be ground with fine emery, after you have done one ſide of your glaſs; for the oftener theſe are ground together, you will be the more ſure of having your figure true.